

CSE 486/586 Distributed Systems
Midterm
Type 1
Wednesday, 3/12/14

DIRECTIONS

- Please write your name, your person number, and the exam type (type 1) on your answer sheet.
- Time limit: 40 minutes (3:10pm - 3:50pm)
- There are 50 points.
- This is a closed-book, no calculator, closed-notes exam.
- The only exception is your cheat sheet (double-sided, letter-sized).
- You should turn in your cheat sheet as well as your answer sheets at the end of the exam.
- Each problem starts on a new page.
- Please use a pencil distributed at the beginning of the exam. If you use anything else, it won't be graded.
- Every question is "atomic," i.e., there are no partial points.

| | |
|----------|--|
| Name | |
| UBITName | |

| | |
|-------------|--|
| Total Score | |
|-------------|--|

1. (4 points) Consider the following statements.

- (a) Ping-ack failure detectors can eventually detect every process failure in synchronous systems.
- (b) In a synchronous system, if a ping-ack failure detector detected a failure, it means there is a crashed process.
- (c) In asynchronous systems, you can distinguish a message delay and/or loss on a network link from a faulty process.
- (d) Ping-ack can accurately detect failures in synchronous systems.

Choose *all* incorrect statements. Or, if there is no incorrect statement, choose:

- (e) There is no incorrect statement.

Answer: (c)

2. (7 points) Consider the following algorithm that attempts to guarantee consensus.

Algorithm for process $p_i \in g$; algorithm proceeds in $f+1$ rounds

On initialization

(a) ----- $Values_i^1 := \{v_i\}; Values_i^0 = \{\}$;

In round r ($1 \leq r \leq f+1$)

(b) ----- $B\text{-multicast}(g, Values_i^r - Values_i^{r-1}); //$ Send only values that have not been sent
 $Values_i^{r+1} := Values_i^r$;

while (in round r)

{

On $B\text{-deliver}(V_j)$ from some p_j

(c) ----- $Values_i^{r+1} := Values_i^{r+1} \cup V_j$;

}

After $(f+1)$ rounds

(d) ----- Assign $d_i = \text{minimum}(Values_i^{f+1})$;

Suppose that the above algorithm is used in an asynchronous system to reach consensus.

If the algorithm does not guarantee consensus, choose *all* statements (from (a) to (d)) that cause the algorithm to not guarantee consensus. If the algorithm does guarantee consensus, then choose:

(e) The algorithm guarantees consensus.

Answer: (b)

3. (5 points) Consider the following statements about event ordering.

(a) It is possible that one message sequence satisfies all three types of ordering (i.e., FIFO, Causal and Total).

(b) Consider the following event scenario with three processes,

P1: m0, m1, m2

P2: m3, m4, m5

P3: m6, m7, m8

Cross-process happened-before: $m0 \rightarrow m4$, $m5 \rightarrow m8$

The order of events (m0, m4, m1, m7, m3, m6, m2, m5, m8) satisfies causal ordering.

(c) The sequencer algorithm for total ordering also maintains FIFO ordering.

Choose *all* correct statements. Or, if there is no correct statement, choose:

(d) There is no correct statement.

Answer: (a)

4. (6 points) Consider the following event scenario with three processes:

- P1: m1, m2, m3
- P2: m4, m5, m6
- P3: m7, m8, m9
- Cross-process happened before: $m2 \rightarrow m9$, $m5 \rightarrow m7$

Which of the following statements are correct?

- (a) (m1, m7, m4, m8, m5, m2, m3, m9, m6) satisfies FIFO.
- (b) (m1, m7, m4, m8, m5, m2, m3, m9, m6) satisfies causal ordering.
- (c) (m1, m4, m2, m5, m7, m8, m3, m6, m9) satisfies FIFO.
- (d) (m1, m4, m2, m5, m7, m8, m3, m6, m9) satisfies causal ordering.

Choose *all* correct statements. Or, if there is no correct statement, choose:

- (e) There is no correct statement.

Answer: (a), (c), and (d)

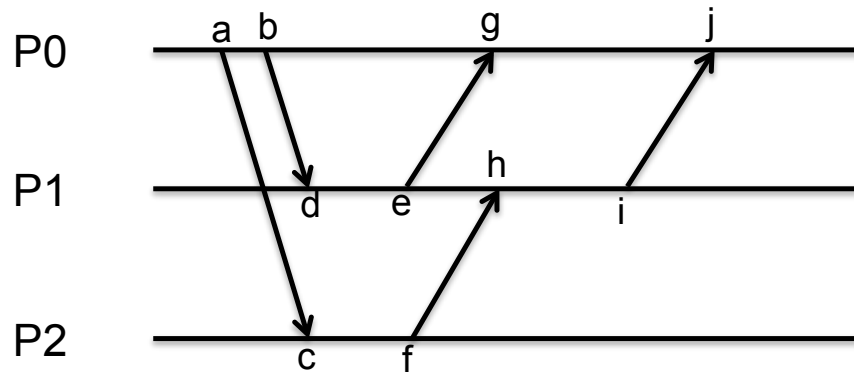
5. (6 points) Assume that five processes communicate with one another through FIFO ordering. Their current sequence vectors are shown below.

| | |
|-----------|-----------------|
| Process A | (5, 4, 3, 4, 1) |
| Process B | (1, 5, 4, 3, 2) |
| Process C | (2, 1, 5, 4, 3) |
| Process D | (3, 2, 1, 4, 4) |
| Process E | (4, 3, 2, 2, 5) |

If Process D sends a message, which process(es) can accept it immediately? Choose *all* processes that can accept it immediately.

Answer: (a), (c), and (d)

6. (6 points) Consider the following diagram.



Using vector clocks to set timestamps for all the events, find the vector clock of event **j** for process P0. Assume all vector clocks are initially set to $(0,0,0)$.

- (a) $(3,2,0)$
- (b) $(4,2,1)$
- (c) $(4,4,2)$
- (d) $(2,5,2)$

Answer: (c)

For the questions on this page, suppose that we are designing a Chord-like, ring-based DHT. In order to map all nodes and objects to the same DHT ring, we are considering the following two mapping functions.

| Name | Function |
|------|--|
| mod | $(ring\ position) = (object\ key\ or\ node\ IP\ addr) \bmod 2^{160}$ |
| SHA1 | $(ring\ position) = SHA1(object\ key\ or\ node\ IP\ addr)$ |

7. (5 points) Choose *all* mapping functions that can provide uniform data distribution.

- (a) mod
- (b) SHA1

Or, if no mapping function provides uniform data distribution, choose:

- (c) None

Answer: (b)

8. (5 points) Choose *all* mapping functions that can result in remapping of all data entries upon a node join or leave event.

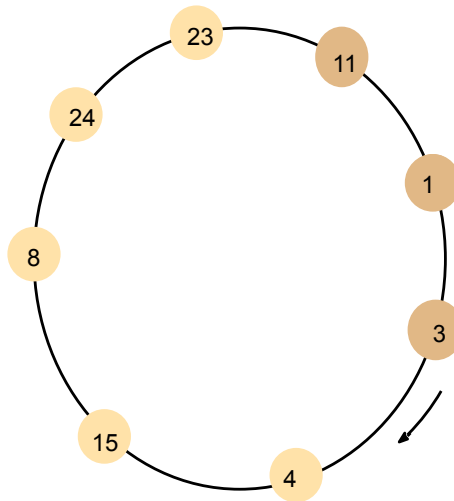
- (a) mod
- (b) SHA1

Or, if no mapping function results in remapping of all data entries, choose:

- (c) None

Answer: (c)

9. (6 points) Assume that the ring-based leader election (Chang and Roberts's) is used with the following ring.



Assume that there is no leader currently. In the best case scenario, which process should start the election? Assume that there is no failure.

- (a) 1
- (b) 15
- (c) 8
- (d) 24
- (e) 23

Answer: (d)